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JOMS:System Architecture for Telemetry and Visualization on Unmanned Vehicle

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Abstract

This paper suggest a different way to get telemetry and visualization data from unmanned vehicle. A simple system architecture called JOMS (JOystick Modified System) is proposed to get those data. With the help of joystick, RC controller and simulink toolbox from MATLAB, the information from unmanned vehicle that associated with rotary and moving principle could be translated into useful data from the unmanned vehicle. Here, potentiometer from the joystick that acts as a variable resistor has been modified. The signals from joystick that interfaced on simulink are processed with some applied mathematical calibration regarding the functionality for certain condition of unmanned vehicle. To verify, the system module has been integrated both on unmanned ground vehicle (UGV) and unmanned air vehicle (UAV) for testing. Moreover, 3D virtual model was developed to ease the unmanned vehicle operator. Finally JOMS, the system architecture proposed successfully suggest a different way to get telemetry and visualization data from unmanned vehicle.

Keywords: Joystick; Simulink; Potentiometer; Unmanned Vehicle; UAV; UGV; Telemetry; Visualization

1. Introduction

Unmanned vehicle is one of the most popular things in robotics areas. Among unmanned vehicle areas there are some category upon the environment that they explore, such as unmanned aerial vehicle

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(UAV)[2], unmanned ground vehicle (UGV) [1], unmanned surface vehicle (USV) [6] and unmanned underwater vehicle (UUV) [7]. Every unmanned vehicle in order to explore successfully the environment and do their task they must equip themselves with an ability to know the environment or an ability to sense the condition surround them, so they can respond to whatever their sensing sense during the exploration. However, most of the equipment that has a good sensing ability usually expensive and also to interface it need other equipment likes microcontroller which cost more for it. Like [2,4] they use inertia measurement unit (IMU) or a gyroscope to know the condition and orientation from their UAV. In most cases, focus development of an unmanned vehicles are not in their sensor. Most researcher focused on how the algorithm or the navigation system to fit their goal [8,9]. In this work, we propose an alternative sensor combined in a system that allows us to get telemetry data and visualization of our unmanned vehicle using joystick input from simulink.

The rest of this paper is organized as follow. Section 2 describes JOM system architecture and the types of JOMS architecture are discussed. Section 3 describes the results and discussion. Finally, the summary of our work is described in section 4.

2. JOMS System Architecture

JOMS is an abbreviation of JOystick Modified System. A system that enables us to get important data such as, orientation and movement condition of unmanned vehicle. This experiment used common USB playstation joystick and common rotational potentiometer. To build the JOM system First, disassembly the joystick and then connect the potentiometer to the analog button circuit that basically is also a potentiometer. With the help joystick input block from Matlab/simulink [3,5] the signal from potentiometer could be read and calibrate. Furthermore signal processing and mathematical calculations are needed to generate the function that we want from the rotary and moving principle that applied.
There are 2 system architectures hardware on how to get visualization condition of unmanned vehicle and its telemetry data. There are:

1. Laptop/computer on unmanned vehicle
2. Passive transmitter on unmanned vehicle

2.1. Laptop/computer on unmanned vehicle

Joystick directly connected to the computer running simulink to read the signal through joystick input. Wifi is used to transfer data read from the computer on board in unmanned vehicle to the operator computer (See Fig.1) for visualization and telemetry through UDP protocol. Fig.2.a. shown the configuration of 2 potentiometers as an inclinometer sensor to show the roll and pitch condition of the robot. Fig.2.b. shows the configuration of 1 potentiometer to act as a rotary encoder. With a simple signal processing according to the application that depends on the desired measurement, see Eq.1. Distance of travel from unmanned vehicle could be achieved with C as Circumference of unmanned vehicle wheel or tracked, n as wheel or tracked partition and sum of signal condition (-1,0,1).

Fig.1. Operator System

Fig.2.JOMS module(a) Pendulum as inclinometer.
(b) Potentiometer as rotary encoder.

$$s = \frac{c_{wheel}}{n_{wheel\,partiton}} \cdot \sum_{signal\ input\ condition} \tag{1}$$

$$\propto_{uv} = \propto_{POTLIM} . Signal_{input\ condition} \tag{2}$$

Every rotary potentiometer has an angle limitation (POTLIM), varies based on the manufacture itself. Most potentiometer has 90° to 120° of rotation limitation. From there, the range signal input given by the joystick can be process to get exact calibration of inclination (see Eq.2). Fig.3 shown the whole JOMS architecture system for laptop on unmanned vehicle condition.

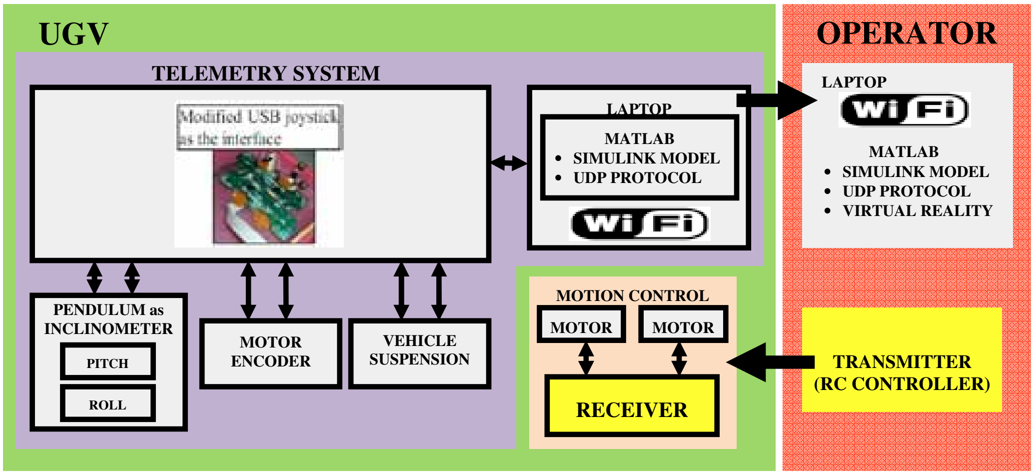

Fig.3. JOM System architecture for laptop/computer on unmanned vehicle (UGV CASE)

2.2. Passive transmitter on unmanned vehicle

This architecture usually adopted in UAV or small unmanned vehicle because it was too heavy to carry a laptop on board. Here we need another transmitter in unmanned vehicle to control joystick on the operator side. With 2 transmitter-receiver modules, 1 in operator side (See Fig.5) to control the movement of unmanned vehicle likes usual and 1 more in UAV side to control joystick on the operator (See Fig.4) based on the gravitational force that occurs during action or based on an input that we want to get from, for example in UAV, like the condition of rudder and aileron that can be obtained by coupling the potentiometer with the servo that moved rudder and aileron. Fig.6 shown the whole JOMS architecture system for passive transmitter on unmanned vehicle condition.

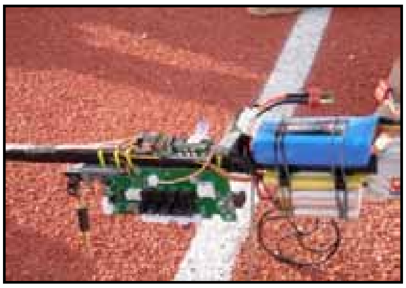

Fig.4. JOMS module -Passive transmitter in UAV

Fig.5. JOMS module - Joystick and passive receiver in operator UAV

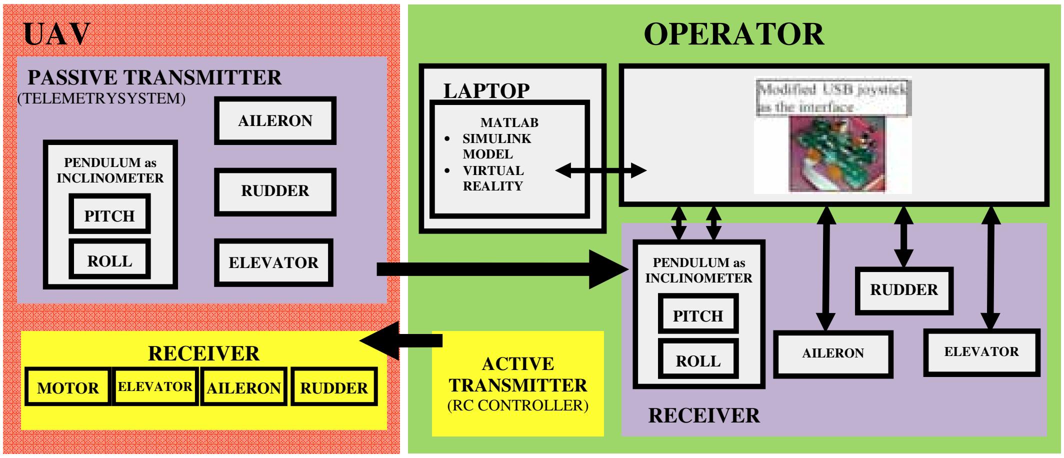

Fig.6. JOM System architecture for passive transmitter on unmanned vehicle (UAV CASE)

3. Experimental procedure

To ensure the JOM system works, here 2 tests are carried out both in UGV and UAV that already has JOM system integrated inside it.

UGV test. Here in UGV test, an obstacle is prepared to impede the movement of UGV. While UGV climb the obstacle, the tilt of pitch and roll data was recorded.

UAV test. Here in UAV test, a flight test was conducted to see the tilt of the pendulum affected with UAV tilt, while UAV fly with an ellipse pattern, right from takeoff and landed.

4. Result and discussion

4.1. Laptop/computer on unmanned vehicle

As shown in Fig.7 the Pitch and roll condition of the UGV, while climbing the obstacle in front of it. At first the green lines show the pitch in minus degrees that is because of the collision that UGV had whiled tried to climb the obstacle. The blue lines also show some movement of rolling condition at first, due to the collision. After that the pitch and roll condition became stable once the UGV climb the obstacle. In Fig.8 we can see the 3D virtual condition of UGV while moving in operator system.

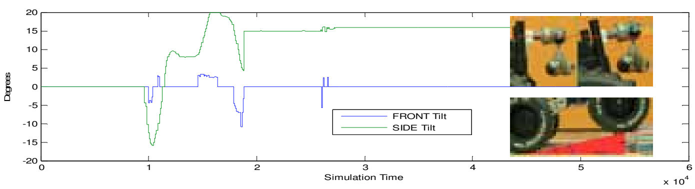

Fig.7. Pitch and roll condition of UGV while climbing

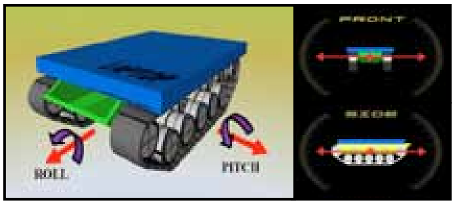

Fig.8.JOMS 3D virtual monitoring

4.2. Passive transmitter on unmanned vehicle

The Fig. 9 shown us the change of pitch and roll condition of UAV in form of chart, while the Fig.11 shown us the 3D virtual condition of UAV during the flight test and Fig.10 shown the flight test that conducted in this study.

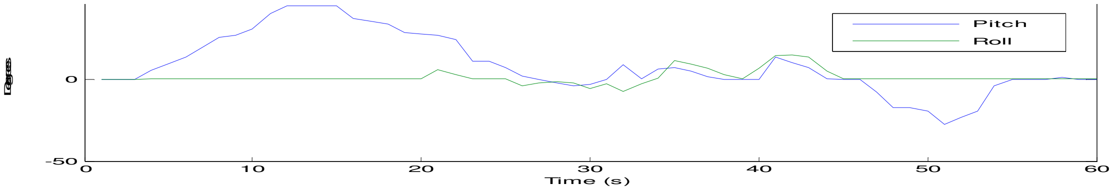

Fig.9.Pitch and roll condition of UAV during the flight test

Fig.10.UAV Flight test

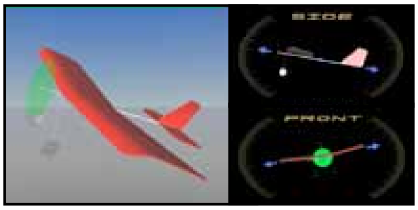

Fig.11.JOMS 3D virtual monitoring for UAV

5. Conclusion

In this paper, we successfully suggest an alternative approach to get telemetry data and visualization for both UGV and UAV. Although it might not accurate as compared to the "real" sensor but it was promising to get telemetry data that we need. With help of matlab/simulink toolboxes, a signal processing and a simple mathematical calculation the data from our unmanned vehicle can be used. It is an alternative approach that finally achieved for developing telemetry and visualization system for unmanned vehicle.

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